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for

Accelerated Testing Techniques for SpaceMechanisms

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Summary of Research

Pin-on-disk tribology experiments were conducted on a perfluoroalkylether (PFPE) liquid lubricant with and without a new PFPE lubricant antiwear additive material, a silane. It was found that the silane provided moderate improvement in the antiwear performance of the PFPE lubricant when applied to the disk or pin surface as a coating or when added to the PFPE as a dispersion (emulsion). Slightly lower wear results were obtained by using the combination of a surface coating and an emulsion of the silane. The silane emulsions or coatings did not affect the coefficients of friction of the tests. Micro-Fourier Transformation Infrared (FTIR) spectroscopy analysis was performed to study silane transfer films and the degradation of the PFPE. The silane was found to mitigate degradation of the PFPE which may have been the primary reason for the antiwear performance.

The static decomposition studies by Ng et al. and Morales led to the idea of using a silane to minimize PFPE decomposition and the wear of the sliding surfaces under boundary lubrication conditions. To evaluate this concept, an experimental program was developed using a pin-on-disk tribometer to investigate the friction, wear and degradation of a PFPE oil under boundary lubrications over short and long term sliding conditions. The silane was applied as a coating to the sliding specimens or as a dispersion (emulsion)to the PFPE liquid. Optical microscopy and (FTIR microscopy examinations of the oil and surfaces were conducted to evaluate decomposition products.

Pin-on-disk tribology testing coupled with surface profilometry, optical microscopy and (FTIR studies on a PFPE liquid lubricant with and without silane additives and/or emulsion indicate that:

(1) Silane coatings and/or emulsions used in conjunction with PFPE oils eliminated PFPE degradation products which were found on ball wear surfaces on tests with the untreated oil, giving strong evidence that the silane can mitigate the degradation of this particular PFPE oil

(2) Accompanying the reduced degradation of the PFPE oil was reduced wear of 440C balls and disks when compared to similar tests on an untreated PFPE oil.

(3) Equal improvements in decreased wear rates were obtained for disk coatings and oil emulsions; although no attempt was made to optimize either application method.

(4) Optical and (FTIR microscopy observations indicated that the silane disk coatings could form thin layer-like transfer films on ball wear surfaces.

(5) Friction coefficients obtained from PFPE oil tests using silane emulsions or silane coatings were the same as those obtained from tests using the untreated PFPE oil.

Publications Resulting from Research

Morales, Wilfredo, Fusaro, Robert L., Siebert, Mark, Keith, Theo, Jansen, Ralph, and Herrera-Fierro, Pilar, "A New Antiwear Additive/Surface Pretreatment for PFPE Liquid Lubricants," NASA Technical Memorandum 107038, December 1995.

Siebert, Mark W., "Effect of Atmosphere and Normal Load on Friction and Wear of Polymide and Ion-Plated Gold in Rolling Contact," MS Thesis University of Toledo, December 1994